colored with methyl blue on floor beside bed, with interruptions of glass tubing at two points, near wound and near bucket, to observe flow of pus, siphon drainage being thus established. No aspiration of the solution in the bucket occurred. An excellent and steady flow of pus was maintained and Ralston James exercise practised. The apparatus was removed on June 18th, and a short tube left in with simple dressing. Tube left out July 10th. July 16th, no discharge, no fever. July 25th, entirely healed, no dressing, gaining flesh rapidly. Discharged to duty August 9th; recovery complete.

Case V.—R. H. B., apprentice, aged sixteen years and eight months, enlisted at Saginaw, Mich. Admitted to hospital August 24, 1902. Croupous pneumonia, left lower lobe. Crisis, September 1st, followed by irregular temperature. Pleural effusion developed. September 13th, aspiration sixth interspace in midaxillary line drew 100 c.c. of pus. Next day, September 14th, patient propped to sitting posture, local anæsthesia with ethyl chloride, free incision same situation, about 350 c.c. pus withdrawn. Two tubes introduced. Ralston James exercise. Expanding lung pushed out the last of a shortened tube October 4th. Wound healed by October 15th. Recovery complete, and discharged to duty, October 27th.

TRAUMATIC INTRAPERITONEAL RUPTURE OF THE BLADDER:

WITH A REPORT OF TWO CASES AND AN ANALYSIS OF ONE HUNDRED AND TEN CASES TREATED BY LAPAROTOMY.

By Astley Paston Cooper Ashhurst, M.D.,

SURGEON TO THE OUT-PATIENT DEPARTMENT OF THE EPISCOPAL HOSPITAL; ASSISTANT SURGEON TO THE ORTHOPÆDIC HOSPITAL AND TO THE DISPENSARY OF THE GERMAN HOSPITAL, PHILADELPHIA.

Having had occasion recently to operate on a patient with an intraperitoneal rupture of the urinary bladder, an operation which is rather rare even in these days of hourly abdominal sections, I have thought it worth while to record the case, and to present a statistical study of all the similar operations, one hundred and ten in number, of which reports have been found.

Of the three patients with this lesion that I have myself observed, the first was operated on by my father at the Pennsylvania Hospital while I was still an undergraduate, and was reported by him to the Philadelphia Academy of Surgery in 1898; while the two others came under my notice at the Episcopal Hospital, and have not hitherto been published.

Case I.—Otto N., German, aged fifty-one years (No. 2449, P. E. H., 1904) was brought to the Episcopal Hospital shortly after midnight on the morning of October 24, 1904. He was admitted to the service of Dr. Richard H. Harte, to whom I am indebted for the privilgee of operating, and of reporting the case.

The patient had been drinking on Saturday evening, October 22d, and on his return home that night fell on the street and against the door-steps. He had passed his urine about 6 P.M., and thinks he fell about 9 P.M. He felt immediately sharp epigastric pain, and was helped into bed, where he slept off his intoxication. A physician who was called to see him the next (Sunday) morning, passed a catheter, but drew only a little blood, and the patient was not relieved of his desire to urinate, which he had been totally unable to do since the accident. Purgatives were administered, but failed to open the bowels; the patient vomited everything, and finally the vomitus became fecal in character. His belly swelled up, was intensely tender, and the patient suffered great pain. Toward midnight his physician sent a note to the hospital, requesting that the ambulance be sent for the patient, whose malady he had diagnosed as intussusception.

On admission to the hospital, I found the man's abdomen very much distended, and extremely tender throughout. Rigidity was not very pronounced, owing to the great distention. There was dulness in the hypogastrium and the flanks, and the level of this dulness changed with the position of the patient. He vomited from time to time bile and black fluid, not very fecal, yet not altogether characteristic of blood. Examination of the lungs detected a few rales in the bases posteriorly. The heart appeared normal. The pulse was 120 and peritonitic in type. The temperature was 97.8° F.

A rubber catheter was passed, but nothing ran. The bladder was then injected with almost one quart of hot boric acid solution. None of it returned, nor was any appreciable change made in the hypogastric dulness. On withdrawing the catheter, its eye was seen to be plugged with a blood clot. The catheter was, therefore, again passed, and five and one-half pints of bloody urinous fluid were withdrawn. The fluid continued to dribble out, and as no material change was produced in the level of the hypogastric dulness, even by the evacuation of this large qantity, it was concluded that the urine was slowly draining from the peritoneal cavity through a rent in the bladder. The urine was so very bloody, however, that I suspected active hemorrhage from some other source within the abdomen. An enema was effectual in moving the bowels, and the patient was prepared for operation.

Laparotomy was done at 2 A.M., thirty hours after the injury. An incision of about two inches in length was made in the left rectus muscle, in the hypogastric region, close to the linea alba. The abdominal fat was one inch in thickness, and there was also at least one inch of peritoneal fat. A very fatty omentum presented in the wound, and almost immediately bloody urinous fluid welled up. The incision was then extended down to the pubes, and subsequently upward, its total length reaching five inches. The pelvis was full of this fluid, and nothing could be seen; blood clots floated up from the flanks. The small intestines were seen to be intensely congested, so I sought in them for the seat of hemorrhage, and found the under surface of the mesentery greatly lacerated and bleeding freely. This appeared to be about three or four feet from the ileocæcal juncture—probably the coil of ileum which normally lies in the pelvis, and which, I presume, was crushed against the spinal column by the vulnerating force. The bleeding from the mesentery was readily controlled by the application of a few purse-string sutures, and I then found that the serous coat of the ileum, a few inches farther down, was split off the bowel transversely, from one mesenteric attachment to the other, in several places. A few Lembert sutures were, therefore, introduced to try to overcome the defect, but without much success, as the bowel was so greatly distended, and I was fearful of prolonging this, the introductory stage of the operation.

Having thus checked the hemorrhage, I mopped out the pelvis, and by lowering the head of the table, and packing off the intestines with gauze, was at last able to see the rent in the bladder, which was on its posterior wall, and seemed to start extraperitoneally between the rectum and bladder, on the patient's right, and to slant forward nearly anteroposteriorly almost to the median line, its whole intraperitoneal length being between three and four inches. The bladder was collapsed, and the rent seemed so large in proportion to the size of the bladder that it was only the mucous lining of the two flaps, forming the lateral walls of the bladder, that enabled me immediately to recognize the condition of affairs present. With great difficulty, on account of the thickness of the abdominal walls and the deep seat of the rent in the bladder, I succeeded in placing seven interrupted Lembert sutures of silk. I inserted the superior sutures first, making the first three of the type of mattress sutures, and using them as guys to pull the bladder up toward the abdominal wound. If the patient's condition had not been so precarious I should have made all seven sutures of the mattress type, but the last four sutures were so extremely difficult to place that I was thankful to be able to insert even the ordinary Lembert sutures. The patient had meanwhile become nearly pulseless, and was being given saline solution intravenously.

The peritoneal cavity was now thoroughly irrigated with hot saline solution; a glass drainage tube was placed to the pelvis, and the upper part of the abdominal wound was closed with "through-and-through" sutures of silkworm-gut. A permanent catheter was placed in the bladder, and the patient returned to bed. The duration of the operation was fifty minutes.

The patient's pulse improved, he rallied from the ether, and became clear in his head; some nearly clear urine was drained away by the catheter; the abdominal tube was evacuated at suitable intervals, but the patient died suddenly, with dyspnœa, at 7 A.M., four hours after the conclusion of the operation. Being a Coroner's case, no autopsy was permitted.

CASE II.—George M., aged thirty-six years (No. 1559 P. E. H., 1901), on the evening of July 15, 1901, fell six feet while at work, striking his hypogastrium on a stone. He had been drinking water and beer during the afternoon, but was not intoxicated, and had eaten neither his midday meal nor his supper. He had voided his urine about one hour before the accident. He was at once brought by the patrol wagon to the Episcopal Hospital, being admitted to the service of Dr. Harry C. Deaver, to whom I am indebted for permission to report the case. The patient suffered great abdominal pain, and desired to urinate, but was unable to do so. A little bloody urine was drawn by the catheter. A pint of boric acid solution injected into the bladder was all returned. Evidences of serious intra-abdominal injury being, however, unequivocal, exploratory laparotomy was done about two hours after the accident by Dr. Deaver. The abdomen was full of blood-tinged fluid, but no urinous odor was detected. The stomach and intestines were examined and found to be uninjured. The pelvis was then examined, and a rent three inches long was discovered in the fundus of the bladder. This was closed with a continuous Lembert suture; the peritoneal cavity was thoroughly irrigated with hot saline solution; a glass drainage tube was placed to the pelvis, and a permanent catheter introduced through the urethra. The patient did well after the operation. Thirty-nine ounces of nearly clear urine were drained off by the catheter during the first twenty-four hours; the peritonitis subsided, and the abdominal drain was discontinued at the end of a week. Cystitis developed on the sixth day, but yielded to treatment, and the patient was discharged cured on the thirty-second day after admission.

HISTORICAL. The Dutch surgeon, von Roonhuysen,* in the seventeenth century, was the first clearly to describe rupture of the bladder. Bonetus† in 1679 records the case of a patient treated by paracentesis abdominis, but with fatal result. Benjamin Bell‡ in 1788 first proposed, and Walter,§ of Pittsburg, in 1862 first successfully employed abdominal section.

With the advent of antisepsis, the treatment by laparotomy and suture of the rent was placed on a sure basis, and has been the accepted method of treatment ever since. The classical statistics of Bartels* in 1878 of ninety-eight cases treated without operation with a mortality of nearly 96 per cent. became more and more unfavorable when compared with a death rate after operation of 62.5 per cent. from 1880 to 1890; of 54.28 per cent. from 1890 to 1900; and of 27.91 per cent. during the last five years.

---

* Medico-Chirurgical Observations, Englished out of Dutch, London, 1676, p. 128

† Sepulchretum, Genevæ, 1679, Lib. III. Sec. xxiv. Obs. 12, p. 1231.

‡ System of Surgery, 2d ed., Edinburgh, 1788, vol. v. p. 305.

§ See list of cases.

FREQUENCY. Although, as may be seen from the first table appended to this paper, from seven to eight cases of traumatic intraperitoneal rupture of the bladder are now being reported yearly, it is still a comparatively rare accident. Conley thirteen years ago stated that among 8000 surgical cases in Cook County Hospital, Chicago, from 1889 to 1893, only five were traumatic rupture of the bladder. At the Episcopal Hospital in this city there were treated, from January 1, 1900, to January 1, 1905, 8367 surgical ward-patients; among this number there were thirty-six instances of injury to the abdominal viscera (0.43 per cent. of the whole), while among these thirty-six patients only three suffered from intraperitoneal rupture of the bladder. That is to say, intraperitoneal rupture of the bladder formed 8.33 per cent. of all abdominal injuries, and was met with but once among every 2789 patients. Intraperitoneal rupture is a much more frequent injury, however, than is extraperitoneal rupture, this latter forming only about 10 to 20 per cent. of all cases of rupture of the bladder.

The records of one hundred and ten patients treated by laparotomy have been examined, the original reference having been consulted in every case in which it was accessible to me, and in other cases I have taken pains to indicate the medium of information.†

Out of the whole number of records examined, it appears that sixty-three patients recovered, and forty-seven died, a total mortality of 42.72 per cent.

CAUSES. The causes of rupture of the bladder may be classed as *predisposing* and *exciting*. Among the former the preponderating influence of *sex* is apparent from the fact that, of the one hundred and four patients, whose sex is mentioned, ninety-four, or over 90 per cent., were male, and only ten were female. Mere liability to injury is probably not the only explanation for this marked difference. It has been pointed out by various writers that women are more prone than men to allow their bladders to become overdistended, and some authors have thought that the greater size of the pelvis in women and the lateral, rather than the anteroposterior expansion of the bladder, in the female sex, rendered this organ less liable to rupture, even when distended. So that, even were women exposed to injury as often as men, it is not probable that their bladders would be ruptured with the same frequency. It has been suggested, moreover, that the short urethra of the female may serve as a sort of safety valve, allowing immediate expulsion of urine and collapse of the bladder when this viscus is subjected to sudden compression. It is curious to observe in this connection that in McLaren's first patient, a male, urine spurted from the penis as the cart wheel, which produced the intraperitoneal rupture, passed over the patient's abdomen. Although the death rate was over 72 per cent. among the female patients, and less than 36 per cent. among the male, this difference is more apparent than real. For of the eight deaths among the female patients, only four were in cases of uncomplicated rupture of the bladder, the other four fatalities being met in (1) a child of seven years, who had fallen from a bridge to a passing boat, sustaining a diastasis of the sacro-iliac joint; (2) in a woman of twenty-eight years, who had a fracture of the base of the skull as well as of the pelvis; (3) in a girl of three and a half years, who was injured by a crushing accident, and had also a rupture of the intestine; and (4) in an adult patient, who was violently and repeatedly kicked in the abdomen by her drunken husband, and then thrown out of the window. If, therefore, these exceptional cases were disregarded, the mortality for the two sexes would be less markedly divergent.

---

* Archiv f. klin. Chir., 1878, xxii., 519, 715.

† There are certain cases included in previous tables, the reports of which it has been impossible to find. These cases—notably Halstrom's patient, quoted from the Lancet of June 28, 1888, and Hitchcock's second patient, quoted from the Pittsburgh Medical Review, 1888, ii. 55—have therefore not been included in my analysis, no trace of such records having been found in the journals referred to.

In regard to *age,* it is naturally found that young adults—those who are most exposed to trauma of various kinds—form by far the larger proportion. Fifty three patients, or 60 per cent. of the number whose age is recorded, were between twenty and forty years of age. The youngest was a girl of three and a half years, who died, and the oldest were two men of fifty-six years, both of whom recovered (Braun, Gangitano). The mortality rates for various ages may be seen in the appendix, Table IV.

Another predisposing cause of importance is the condition of *intoxication.* Over 72 per cent. of the patients, in whose records this point is mentioned, are reported as being more or less drunk at the time of the injury, and it is a sad fact that in not a few instances in which the patients themselves were sober, they sustained their injuries because of intoxication in someone else (Rose, Zeldowitch). Not only does drunkenness predispose to injury in this way, by making the individuals both quarrelsome and unsteady on their feet, but it increases the amount of urine excreted, and by dulling the sensibilities renders the persons so affected often unconscious that their bladders are overdistended, and may even deprive them, when drunkenness is a long-continued habit, of the power of completely evacuating their bladders. The result of this last state—atony of the bladder—is that, although the patient may have passed his urine within an hour or so of the accident, his bladder may still be quite sufficiently distended to predispose it to rupture when subjected to sudden injury. Another serious aspect of intoxication in these patients is that they frequently remain unconscious of the gravity of their injury, as in the case of my own patient, and sleep off their drunken state only to awake the next morning with a peritonitis fully developed, which could almost certainly have been prevented by prompt operation.

It is worthy of note that among the patients who were intoxicated at the time of the accident, the mortality was over 43 per cent.; while among the sober it was less than 28 per cent.

Distention of the bladder, apart from drunkenness, is itself an important predisposing cause. Even sober patients, hurrying to a urinal in the dark, have bumped against a post and ruptured their bladders, which would not have been in a condition to be injured had the calls of nature been attended to at an earlier hour.

The exciting causes of this affection are conveniently described as *blows*, *falls*, and *crushes*, corresponding to the somewhat humorous classification of patients into the quarrelsome, the drunk, and the innocent, originally made by Bartels. I do not find, however, that the cases of injury sustained through falls comprise all the patients who were intoxicated, nor that all the crushes were in patients who were innocent of drink. In sixteen cases the character of the injury is not stated, but it is given as a blow in twenty-nine cases, as a fall in forty-five, and as a crush in twenty. Of patients injured by a blow, 82.35 per cent. were drunk, and the mortality among such cases was 55 per cent; of those injured by a fall, 73.53 per cent. were drunk, and the mortality for these patients was 35 per cent.; while of those patients injured by a crushing force, only 38.46 per cent. were drunk, and the mortality under such circumstances was no more than 26 per cent. These figures, thus combined, show at once the life-saving value of early operation, and the lethal influence of intoxication. In the severest class of injuries—crushes—in which there is frequently some bony injury, and some visible contusion of the soft parts, the patients are hurried in patrol wagon or ambulance to the nearest hospital, and appropriate treatment is instituted with the least possible delay, and in such cases the death rate is considerable lower than in either of the other classes, in which the vulnerating force is often so trivial, or the fall so slight, that the patient walks miles, perhaps, to his home, or even to a hospital, and is there treated by simple catheterization, or not at all, and so fails to secure adequate relief until peritonitis is so far advanced as to make recovery very unlikely.

I have not included in this series any patients in whom the bladder was the seat of what has been called spontaneous rupture. These cases belong, with those due to perforation from ulcers and tumors, in a class by themselves, and cannot justly be considered traumatic ruptures in the strict sense of the term.

Clinical Pathology. The mechanism by which the bladder is ruptured has always been a subject of interest. It can best be discussed after studying the lesions produced by the injury. Of ninety cases in which the *site* of the rent is mentioned, in seventy it is stated to have been in the "dome," "fundus," or upper posterior wall of the bladder; in eight cases it was on the lower portion of the posterior wall, toward the rectum; in nine cases it extended from the dome down to the rectum, and in only three cases was it so far removed from the median line of the body as to be classed as being on the "lateral" wall. Since the peritoneum does not extend far on to the lateral walls, and as these rents were all of them intraperitoneal, it is evident that the term "lateral wall" must be interpreted as meaning the lateral portions of the posterior wall. There were eleven cases in which the rent, besides being intraperitoneal, extended for a short distance on to the extraperitoneal surface of the bladder, most frequently into the space of Retzius, but in a few instances involving the base and neck of the bladder. In three cases there were two rents; one intraperitoneal rupture, and a second, distinct extraperitoneal rent. In no case was there more than one rent situated intraperitoneally.

The *direction* of the rent is also of interest in connection with the mechanism. This matter is noted in fifty-three instances, the rent being in the sagittal plane in twenty-five cases; being irregular or oblique, but still more or less anteroposterior in nineteen cases, and in only nine cases taking a transverse or coronal course.

The *size* of the rent is of interest mainly from the point of view of recovery. In eighty-seven cases the dimensions of the rent in the bladder are given, and they may be classed in the following manner: Five cases, less than half an inch, with no deaths; thirty-six cases, less than two inches, with a mortality of 41.6 per cent.; forty-one cases, less than four inches, with a mortality of 46.3 per cent.; and five cases, where the rent was over four inches in length, the mortality in these cases being 40 per cent.

As pointed out by Dambrin and Papin, who have devoted special attention to the mechanism of these injuries, that portion of the bladder in which ruptures are most frequently found is naturally the weakest part. At the fundus of the bladder the muscular fibres are nearly all more or less anteroposterior in direction, and diverge to become circular around the urachus or to ascend along it. The serous coat of the bladder is the least elastic, and therefore most disposed to split of all its tunics. In consequence of this fact, the peritoneal surface of the bladder gives way more readily, on the application of a compressing force, than does any part of its extraperitoneal surface. Moreover, the fundus of the bladder is practically unsupported by external agencies. Posteriorly and at the sides, the distended bladder is supported by the pelvis—the rectum and the pelvic muscles acting in some sort as buffers; while in the hypogastric region, where the vulnerating force is usually applied, the force itself, and the abdominal muscles, support the bladder, leaving its summit, its naturally weakest part, the only portion practically unsupported. Accordingly, the ruptures take place most frequently in this region, and follow usually the natural anteroposterior course of the muscular fibres of the bladder wall; for the circular fibres are relatively feeble, and are torn transversely much more easily than the strong, longitudinal fibres would be.

When the bladder is only partially distended, and when the vulnerating force is applied from above downward and backward, it seems probable that the posterosuperior aspect of the bladder is well supported, and that the rupture is apt to occur on the extraperitoneal surface, near the obturator or ischiatic foramina, the two areas on the pelvic aspect of the bladder least well supported. The experiments of Berndt* lend support to this theory.

When the original force fractures the pelvis, the rent in the bladder is much more likely to be extraperitoneal than intraperitoneal. Fully three-quarters of cases of ruptured bladder, complicated by a fracture of the pelvis, have been found by various investigators to be extraperitoneal in character. And in the extraperitoneal cases the rent is usually produced by perforation of the bladder by a fragment of bone, or from separation of one of the pelvic joints tearing the bladder open; but in the cases in which an intraperitoneal rent accompanies fracture of the pelvis, it is nearly always evident that if the rupture had not been intraperitoneal, there would have been no rupture at all—in other words, that the bladder rent is produced not by the fracture of the pelvis, but independently of it, by the same original injury which produced the fracture. Among the one hundred and ten cases tabulated there were fourteen instances of fracture of the pelvis, with a mortality of 35.71 per cent.

In at least four instances the theory of "contre-coup," or "general concussion of the body," has been invoked to explain intraperitoneal ruptures of the bladder. In Cusack's† case the patient suffered a general concussion of the body, and there was no clear history of abdominal injury. Kerr's patient fell "all doubled up" on his left hip; Roll's patient fell on the buttocks; and Bayard Holmes' landed on his feet and left hand.

SYMPTOMS. The sensations of the patient are so frequently dulled by his intoxicated condition that much more value can always be placed upon a physical examination. Of all symptoms, abdominal pain is naturally the most frequent, and is nearly as often felt in the epigastric as in the suprapubic region. It is, of course, in no way distinctive of rupture of the bladder. But there are certain symptoms so characteristic that they at once suggest the nature of the injury. The most important of these is at once a symptom and a physical sign, and has been graphically described by Rose under the name "*blutige Anurie*"—bloody anuria. The patient is eagerly desirous of passing urine, but is totally unable to do so; he may succeed in expelling a few drops of bloody fluid, but it is not to this that the term bloody anuria properly applies; it is to the anuria which is the usual outcome of catheterization. If a patient, after sustaining some abdominal injury, passes blood in his urine, the only natural inference is that his urinary tract is injured, and the question at once arises whether the urethra, the bladder, or the kidney is the seat of the lesion. The character of the injury will almost always exclude traumatism to the urethra, and the ability to pass urine usually determines that the bladder is not ruptured, and so fixes the kidney as the site of the injury. But this last is not always the case, and many a patient has had his chances of recovery from a rupture of the bladder much impaired, if not entirely lost, merely because the examiner has decided that voluntary urination necessarily excluded rupture of the bladder. Examination of the records of eighty-six patients, in whom the question of spontaneous urination is noted, shows that it was present in nine instances, or nearly 11 per cent., a proportion sufficiently large to make dependence on this symptom alone rather fallacious.

---

* Berndt, Archiv f. klin. Chir., 1899, lviii., 815.

† Dublin Hospital Repts., 1818, ii., 312.

The inability of the patient to stand upright, and his persistent tendency to double up his thighs toward his abdomen, has been considered a symptom particularly characteristic of rupture of the bladder. It does not seem probable, however, that it would be more marked in these cases than in oncoming peritonitis from any other cause; but if the patient is seen immediately after the accident, he is more apt to present such symptoms than those of severe shock, which usually are predominant when the intestines are ruptured, allowing the sudden escape of gas into the peritoneal cavity.

There should be no cases in which diagnosis is delayed until the development of peritonitis, for by physical examination, properly conducted, the question of the existence of a rupture of the bladder can be settled to a certainty almost without exception. The introduction of a catheter in cases of suspected intraperitoneal rupture has been strenuously objected to by certain surgeons, who argue that this is the surest way to produce peritonitis; they assert that normal urine is comparatively harmless to the peritoneum, but that a catheter is sure to carry bacteria into the abdominal cavity, and that an exploratory laparotomy is the best method of making the diagnosis. With these gentlemen I am nowise in accord. It appears to me that their premises are ill-founded, and their conclusions accordingly false. Normal urine may possibly, in moderate quantities, be comparatively harmless to the peritoneum. The experiments of Vincent,* and of Strauss and Tuffier,† are of considerable interest in this connection, since they show how long-suffering the peritoneum at times may be. But it should not be forgotten that these experiments were conducted with aseptic urine, which is rarely present in the human being, and is very exceptional in the class of patients composing the usual subjects of intraperitoneal rupture of the bladder. In the average patient the urine is septic, in greater or less degree, and although we know (Ferraton) that the peritoneum can absorb aseptic urine, and that up to the development of peritonitis, urine which is not aseptic may be thus disposed of, yet to make these facts an argument against the use of the catheter in diagnosing rupture of the bladder, appears to me unsurgical in the extreme. With proper care no further contamination of the peritoneum need be feared, and the information gained by catheterization and the accompanying tests, which will be presently discussed, will enable the surgeon to avoid needless laparotomies in an immense number of patients, who would be opened "exploratively" in vain, were the use of the catheter neglected.

---

* *Vide* Hofmokl, loc. cit., S. 1161.

† *Vide* Dambrin et Papin., Ann. d. Malad. d. Org. Gén.-Urin., 1904, xxii., 641.

It seems to me, then, that in suspected cases of rupture of the bladder, a catheter should be immediately passed, but it should, of course, be done with all aseptic precautions. I think a metal catheter is preferable in skilled hands to a rubber instrument. An intelligent surgeon will make a metal instrument act as an exceedingly long finger, in exploring the urethra and bladder, which cannot be done with a flexible catheter. And while I, of course, condemn jabbing the extremity of the catheter about in the bladder with the intent of thus discovering the rent, there can, I think, be no question as to the advisability of gently turning its point hither and thither, and noting the increase or decrease of the urinary flow as these manœuvres are practised. In at least seven of the recorded cases, the rent was found in this manner. The risk of converting a partial into a complete rent by this method, is much less than that of leaving unsutured a rent involving one or two coats of the bladder only.

If this "catheter test" is not employed, or if it is negative, there remains the test known by Weir's* name, which is scarcely less valuable. This consists in first evacuating all urine possible, then injecting a measured quantity of fluid, and finally in seeking to recover all that was injected. As a rule, when the catheter is first passed, little or no urine is obtained. Of seventy-one cases in which the point is mentioned, absolutely no urine was obtained in three; a very small amount of bloody urine was obtained in sixty-one, and in seven cases clear urine was obtained. This shows the overwhelming importance of Rose's symptom of bloody anuria, but it also demonstrates the fact that when so important a symptom is contradicted by the presence of clear urine in one-tenth of the cases, dependence on symptoms alone will lead the surgeon astray.

---

* N. Y. Med. Record, 1887, i., 88.

Hence the value of Weir's test, of injecting the bladder after evacuation has been accomplished. Usually, it is recommended that only ten ounces or a pint be injected. This quantity has, however, on numerous occasions proved insufficient. In Deaver's patient, reported in this paper, one pint was injected, and it was all recovered, and this fact was taken to indicate that the bladder was intact. As a consequence, the bladder was not examined until the other organs, which might have been injured, had been found unhurt. It is safer, therefore, to continue injecting fluid with all gentleness, until a quart has been introduced, unless the development of a hypogastric swelling, characteristic of the unruptured bladder, sooner occurs and by its presence excludes the possibility of a solution of continuity of the bladder walls. Weir's test is recorded as having been employed in only sixteen of the reported cases. Undoubtedly it has been employed in many more, but the reporters have not included it in their record. Of these sixteen cases, it was positive in twelve, and negative in four. In the negative instances the rent in the bladder was only about a half inch in length in two cases (Bolton, Hofmokl); in the third (Deaver) only a pint of fluid was used; but in the fourth (Alexander) the rent was four inches in length, and there is no apparent reason why the test should have proved negative. In Walsham's second patient the test was doubtful, and he accordingly injected air into the bladder. This test was positive to an alarming degree; the abdomen at once became tympanitic; the liver dulness, present before, was suddenly obliterated, and the patient went into a "condition closely resembling collapse." In my own patient the injection test may be said to have been doubtful in a certain sense, although no fluid was recovered at the first attempt, since, after freeing the catheter eye of a clot, a larger amount than was injected was finally evacuated. Yet the very fact that more fluid was recovered than was injected was very good evidence that the superfluous quantity came from the peritoneal cavity and not from the bladder.

The cystoscope is naturally nearly valueless in these injuries, since the bladder cannot be satisfactorily distended. Yet Roll made his diagnosis by its means on the fourth day, and had the satisfaction, some weeks later, of viewing by the same means the scar left in the bladder by his successful suturing of the rent. At the operation the rent in the bladder was found feebly stopped by a prolapsing coil of intestine.

The force with which the stream flows from the catheter, and the intermittent exacerbations of force, due to the compressing action of respiration on the abdominal contents, are signs which have been dwelt upon by some authors as particularly significant of fluid draining from the general peritoneal cavity. For my own part, I should attach little value to these characteristics, as I have seen the same features repeatedly when drawing urine from atonic bladders, in which there was no other expulsive force than that of the abdominal muscles and the diaphragm.

Palpation is of little value, except for the detection of the usual signs of peritonitis. Percussion is much more reliable, and will usually detect not only the distended bladder, if present, but on the application of Weir's test will demonstrate the development of a hypogastric tumor with the characteristics of the bladder if this viscus be still unruptured. The discovery of free fluid within the abdominal cavity, the dulness in each flank disappearing as the patient is rolled to the opposite side, furnishes what is probably as certain proof of the nature of the injury as can be obtained by the ordinary methods of physical examination. The patient might of course be the subject of ascites, or the fluid might be intestinal contents or blood, but as a rule these affections can be ruled out by other symptoms. If the fluid were intestinal contents the shock immediately following the accident would probably have been greater, and the onset of peritonitis would have been correspondingly rapid; while the evidence of internal hemorrhage would in the latter case have probably overshadowed all other symptoms. The absence of movable dulness in the flanks must not, however, be taken to indicate that no urine has escaped from the bladder into the peritoneal cavity. As already remarked, the peritoneum is quite able to absorb a certain amount of urine, and during the first twelve or twenty-four hours may absorb it, if fairly normal in quantity, nearly as rapidly as it is excreted by the kidneys, and hence the urine may not begin to accumulate in the dependent portions of the abdomen until the development of reactive exudation from the peritoneum impairs its absorptive power. This was probably the case in Blumer's patient.

DIAGNOSIS. When the history is clear, and other injuries do not distract the attention of the examiner, the presence of a ruptured bladder need scarcely ever be overlooked. Given a man, drunk, or drinking, who has sustained some abdominal injury, the first organ to be excluded from the category is the bladder. If it be possible to determine that the bladder was full when the accident occurred our suspicions will naturally be re-doubled. The patient *may have felt something give way inside him when he was injured.* Desire to urinate with inability to do so, usually follows as soon as the first shock of impact and the sudden pain in the belly allows the patient to consider his natural feelings. Passage of a catheter then draws no urine, or, at most, a little bloody fluid. With a clear history these facts alone would warrant a surgeon in resorting at once to laparotomy, and it seems incredible that patient after patient has been catheterized and re-catheterized without drawing urine; has been purged and given all manner of drugs by physicians who are supposed to be able to make a diagnosis of intra-abdominal affections, and that the patient has only as a last resort been sent to a hospital, or placed under a surgeon's care, with the ready-made diagnosis of intussusception, extrauterine pregnancy, strangulated hernia, or even merely peritonitis!

TREATMENT. There is no question that the proper treatment is to open the belly, suture the rent, evacuate the urinous fluid, and drain the wound until there is nothing left to drain. With this treatment promptly instituted three out of four patients are being saved at the present time. This increase in the rate of recovery, well shown in Table II, can only be maintained or improved by operating as soon after the injury is received as possible. For practically all operations done within a few hours have been within the last five years. Taking all the recorded cases of operation, it is seen that of those patients operated upon within eight hours, and within twelve hours after the accident, the mortality is practically the same—from 33 to 37 per cent. (Table VII). After twelve hours have elapsed the mortality jumps at once to over 50 per cent. The number of patients operated on over thirty-six hours after the injury is fortunately small, and hence does not allow of any very definite conclusions, but merely shows that the few individuals who have enough vital resistance to live that long, without any operation, have more than the surgeon has a right to expect of his patients. The notorious patient of Ledderhose, who survived the immediate results of the injury, and recovered after the opening, on the seventeenth day, of an intraperitoneal abscess in communication with the bladder, got well, as Zeldowitch sententiously remarks, more by good luck than good management.

The incision in the hypogastric region should be amply large to facilitate rapid operating. A number of surgeons advise first opening the space of Retzius, exploring for extraperitoneal rupture, and then opening the bladder, as in suprapubic cystotomy, and examining the interior of this organ for the evidence of a rent. I do not, myself, see that this course presents any advantages, unless in some exceptional case, in which the diagnosis between extraperitoneal and intraperitoneal rupture had not been made before the operation. On the other hand, such a course presents to my mind many obvious disadvantages. It is primarily a pure waste of time. If the rupture is intraperitoneal, it is perfectly needless to view it from within the bladder, whence it could not be satisfactorily sutured; and by opening the bladder through the space of Retzius we will only be adding a second wound to the one already existing. Even if an intraperitoneal rupture be not accessible when the intraperitoneal surface of the bladder is exposed, the surgeon is at least enabled to evacuate the abdominal fluid, and to take measures for excluding the bladder area from the rest of the peritoneal cavity—matters of much importance, but impossible of accomplishment from within the bladder.

If no other injuries demand immediate attention, the surgeon's first act should be to find the rent in the bladder and suture it. There is no use in cleansing the peritoneal cavity until further soiling of it has been prevented. Degen made the attempt to wipe the abdomen dry before suturing, but abandoned the task, because, as he says, he found it a "Sisyphus Arbeit." Yet it is often necessary to mop a certain amount of fluid out of the pelvis before the bladder can be inspected. For this purpose no method is so convenient and rapid as the use of large marine sponges, which will absorb fluid in much greater quantities than will gauze. The Trendelenburg position facilitates the discovery and suture of the rent, but the use of Peterson's rectal bag (advocated by Weir) is usually needless, and may be harmful. The intestines must be protected and kept out of the way, during the suturing, by means of gauze packs.

The suture material is preferably of silk. It has usually been found quite sufficient to apply a single row of seroserous sutures, reinforcing the first row at one or two points as needed. If the wound is deep, it is best to insert the anterior sutures first, and then to use them as guys in pulling the bladder upward. A long needle holder is a convenience. Care should be taken to approximate closely the posterior extremity of the rent, which is the point most apt to leak. If two layers of sutures cannot be inserted it is best to make the single row interrupted, and of the mattress type, when possible. Such stitches are less apt to tear out, and bring the serous surfaces together more accurately.

Some surgeons have not sutured the rent at all. In eighty-nine instances it was sutured, with a mortality of 38.2 per cent.; and in six cases it was not sutured, with a death rate of 50 per cent. The difference is not so marked as one would expect. In four patients, the rent, though undoubtedly intraperitoneal, could not be found. The mortality in these cases was 50 per cent.

A method of exclusion of the rupture has been advocated by Hellendahl,* and practised by B. Holmes, Föderl, Hildebrand, and Madelung. This plan consists in suturing the edges of the rent in the bladder to the parietal peritoneum of the anterior abdominal wall, thus converting the rupture into an extraperitoneal injury. Drainage of the bladder is then provided through the rupture, which is left open for the purpose, and the peritoneal cavity is separately drained, when necessary, through the upper half of the abdominal wound. This method is not readily applicable to any cases except where the rent is in the dome of the bladder, but B. Holmes and Föderl closed the posterior half of the rupture by sutures, and then stitched the edges of its anterior portion to the parietal peritoneum; while Madelung, in whose patient the serous coat of the bladder was relaxed, as the result of urinary infiltration beneath it, first closed the entire rent with sutures, then laid a strip of iodoform gauze over it, and finally sutured the visceral peritoneum covering the bladder to the parietal peritoneum of the anterior abdominal wall, so that the iodoform gauze somewhat resembled the tube employed in Witzel's method of gastrostomy. Both Hildebrand and Madelung had first opened the bladder through the space of Retzius, and therefore used that wound for drainage.

---

* Inaug. Dissert., Strasburg, 1896.

It seems to me that this rather complicated method possesses no advantages whatever over complete closure of the intraperitoneal rent in the uusal way, except it were in a patient with impermeable stricture of the urethra, in whom no other outlet for the urine existed. Lyot employed a somewhat similar procedure in such a patient, with perfect success. Extraperitoneal wounds of the bladder into the space of Retzius should always be left unsutured, at least in part, since firm adhesion of muscular tissues does not occur promptly enough to prevent leakage of urine from the bladder, and the establishment of at least a temporary urinary fistula. Intraperitoneal wounds, on the contrary, heal with sufficient firmness in so short a time as to justify one in not anticipating leakage. Of the four patients treated by Hellendahl's method, B. Holmes' was the only one that died.

When the intraperitoneal rent can be securely closed, there is, therefore, no need to drain the bladder suprapubically. Injection of the bladder to test the security of the sutures is not advisible.

As soon as the tear in the bladder has been disposed of, the surgeon must devote his attention to the removal of the urine from the general peritoneal cavity. I have already expressed my opinion as to allowing this fluid to remain indefinitely, with the idea that the peritoneum will absorb it. One success, such as in Schramm's patient, by no means justifies us in such a course. As the urine is usually widely dispersed in the abdomen, filling the flanks as well as the pelvis, it can be most quickly evacuated by irrigation, which should be prolonged until the fluid returns clear, and is free from urinous odor. Mopping several quarts of fluid out of the abdomen is a tedious matter, as anyone may know who tries it (experiments are best made on the cadaver), and the repeated insertion and withdrawal of gauze sponges cannot fail seriously to abrade the serous lining of the abdomen. I say this in spite of the fact that my investigations show that among forty patients, treated by irrigation, the mortality was 40 per cent., while among twenty-five, treated merely by wiping, the mortality was only 28 per cent. The difference, as further analysis of the cases shows, consists in the fact that when wiping alone was employed the urine was mostly confined to the pelvis; whereas, in a majority of the patients irrigated, urine, blood clots, and even pus, were present in the kidney pouches, and in some instances around the stomach and liver, as well as in the pelvis.

It is safer to drain the peritoneal cavity by a tube reaching to the rectovesical pouch. By placing the patient in the semi-sitting posture, the retained fluids or any exudation from the peritoneum will thus gravitate to the pelvis, and may be withdrawn through the tube at suitable intervals. It is noted in the case records that fifty-three patients were treated by drainage of the peritoneum, with a resulting mortality of 32 per cent.; while among thirty-nine patients, whose peritoneal cavities were closed without drainage, the mortality was nearly 36 per cent. The difference according to figures is, therefore, of little moment, but it is to be explained, as in the instance cited above, by the fact that the more severe the peritoneal infection, the more apt a surgeon is to drain; that is to say, by means of carefully instituted drainage the mortality of the severe cases has been rendered about the same, in the aggregate, as that of the mild cases. In any case when the integrity of the suture line is doubtful, it is well to protect the intestines from the bladder and the drainage tube by a strip of gauze.

It is also, I think, worthy of notice that among nineteen patients whose bladders were drained suprapubically, either by means of Hellendahl's method, or through a suprapubic cystotomy incision, there were only three deaths—a mortality of 15.78 per cent. These figures, together with the fact that of the twelve patients who developed suprapubic urinary fistula after the operation *not one* died, seem to show beyond doubt that free and constant drainage of the bladder is imperative. As I have remarked before, an intraperitoneal rent can usually be so securely sutured that leakage need not be feared, and the bladder can then be drained by an inlying catheter introduced through the urethra. If the intraperitoneal rent, therefore, cannot be securely sutured, or if there be an extraperitoneal opening, it would seem wisest to provide for suprapubic drainage of the bladder, which has been demonstrated on many occasions to be much more free and complete than perineal drainage or that obtained by an inlying catheter.

If an inlying catheter cannot be tolerated by the patient, he should be catheterized every three or four hours during the first few days; and if even this course produces undesirable pain or inflammation, a urinal should be taken to him every two hours and he should be made to urinate day and night with unfailing regularity, but less often, after the first day or two, until recovery is assured.

STATISTICAL SUMMARY.

TABLE I.

Recovered	63
Died	47
Total	110

Mortality, 42.72 per cent.

TABLE II.

Date.	Operations.	R.	D.	Mortality per cent.
1860–69 . .	1	1	0	00.00
1870–79 . .	2	0	2	100.00
1880–89 . .	24	9	15	62.50
1890–99 . .	35	16	19	54.28
1900–1905 . .	48	37	11	22.91
1860–1905 . .	110	63	47	42.72

TABLE III.

Sex.	R.	D.	Total.	Mortality per cent.
Male . . .	60	33	93	35.48
Female . . .	3	8	11	72.72

(In 6 cases the sex is not recorded);

TABLE IV.

Age.	R.	D.	Total.	Mortality
Less than 5 years. . .	2	1	3	33.33
5 to 10 " . .	2	1	3	33.33
10 to 20 " . .	3	0	3	00.00
20 to 30 " . .	17	7	24	29.16
30 to 40 " . .	17	12	29	41.37
40 to 50 " . .	14	7	21	33.33
50 to 60 " . .	3	3	6	50.00

Age.	Cases.	Deaths.	Mortality per cent.
Less than 20 years. . . .	9	2	22.22
20 to 40 "	53	19	35.84
40 to 60 " . . .	27	10	37.00

(In 21 cases the age is not recorded)

TABLE V.

Character of injury.	R.	D.	Total.	Mortality per cent.
Blow	13	16	29	55.17
Fall	29	16	45	35.55
. . . . .	14	6	20	26.31

(In 16 cases the character of the injury is not stated)

TABLE VI.

	R.	D.	Total.	Mortality per cent.
Intoxicated . .	31	24	55	43.64
Sober. . . .	16	6	22	27.27

(In 33 cases soberness or drunkenness not mentioned)

TABLE VII.

Time between injury and operation.	R.	D.	Total.	Mortality per cent.
Less than 8 hours . . .	10	6	16	37.49
Less than 12 " . . .	10	5	15	33.33
Less than 24 " . . .	16	17	33	51.50
Less than 36 " . . .	3	3	6	50.00
Less than 48 " . . .	7	2	9	22.00
Third day or later . . .	13	6	19	31.57

(In 12 cases the time between injury and operation is not given)

TABLE VIII.

Size of rent in bladder.	R.	D.	Total.	Mortality per cent.
One-half inch or under . .	5	0	5	00.00
Two inches or under . .	21	15	36	41.66
Four inches or under . .	22	19	41	46.34
Over four inches. . .	3	2	5	40.00

(In 23 cases the size of the rent in bladder is not given)

LIST OF CASES ANALYZED.

1. Alexander. Annals of Surgery, 1901, ii. 209.
2. Anderson. Australasian Med. Gaz., 1905, xxv. 19.
3. Ashhurst, Prof. Records of University Hospital, Phila., Nov. 14, 1890.
4. Ashhurst, Prof. Annals of Surgery, 1898, ii. 385.
5. Ashhurst Astley. Records of Episcopal Hospital, Phila., Oct. 24, 1904.
6. Bajardi. *Vide* Martini, Clinica Chir., Milano, 1904, xii. 1037.
7. Bissell. Virginia Med. Semi-Monthly, 1903, vii. 429, Case 2.
8. Blake. *Annals of Surgery*, 1902, *ii*. 606.
9. Blecher. Deutsch. Zeitschr. f. Chir., 1903, lxvi. 578; Zentralbl. f. Chir., 1903, xxx. 852.
10. Blum. Archives Gén. de la Méd., 1888, ii. 5, 25.
11. Blumer. Brit. Med. Jour., 1903, i. 789.
12. Bolton. Annals of Surgery, 1903, i. 438.
13. Bouglé. *Vide* Furbury, Thèse de Paris, 1900, p. 56.
14. Braun. *Vide* Nobe. Centralbl. f. d. Krankh. d. Harn u. Sexual-org., 1903, xiv. 77; Fall 24 u. Fall 25. Also, Jenckel or Senkel, Deutsch. Zeitschr. f. Chir., 1901, lxi. 578.
15. Braun. Munch. med. Woch., 1900, i. 168, Fall B. Also Nobe, Centralbl. f. d. Krankh. d. Harn u. Sexual-org., 1903, xiv. 77, Fall 26.
16. Briddon. N. Y. Med. Jour., 1889, i. 279; Med.-Chir. Trans., 1895, lxxviii. 286.
17. Brown. N. Y. Med. Record, 1888, i. 632.
18. Bull. Annals of Surgery, 1885, i. 67.
19. Collier. Med. Choronicle, Manchester 1902, 4th series, iii. 26.
20. Conley. *Vide* Herrick, N. Y. Med. News, 1893, i. 197, Case I. Also N. Amer. Practitioner, Chicago, 1889, i. 408.
21. Cook. Annals of Surgery, 1905, ii. 863.
22. Cropper. Lancet, 1905, i. 639.
23. Dalziel. Glasgow Med. Journ., 1898, xlix. 370.
24. Deaver, H. C. Records of Episcopal Hospital, Philadelphia, 1901, No. 1559.
25. Degen. Munch. med. Woch., 1896, xliii. 72.
26. Diaconoff or Djakonow. *Vide* Seldowitsch, Arch. f. klin. Chir., 1904, lxxii 883.
27. Duncan. Lancet, 1886, ii. 399.
28. Eiselsberg. *Vide* Dohrn, Deutsch. Zeitschr. f. Chir., 1901, lx. 406.
29. Eisner. Prager med. Woch., 1901, No. 10; quoted in Deutsch. med. Woch., 1901, xxvii. L-B. 69.
30. Engstad. Northwestern Lancet, St. Paul, 1899, xix. 134.
31. Föderl. Wien. klin. Woch., 1905, xviii. 677.
32. Fox. Amer. Practitioner and News, Louisville, Ky., 1886, ii. 220.
33. Gangitano. Giorn. Internaz. d. Sc. Med., Napoli, 1904, xxvi. 27.
34. Grant, H. H. N. Y. Med. Journ., 1888, i. 612; Journ. Amer. Med. Assoc., 1888, ii. 118.
35. Harrison. Brit. Med. Journ., 1903, i. 76.
36. Heath. Med.-Chir. Trans., 1879, lxii. 335.
37. Heaton. Lancet, 1896, i. 991.
38. Hildebrand. Beitr. z. klin. Chir., 1903, xxxvii. 776.
39. Hitchcock. Pittsburgh Med. Rev., 1888, ii. 55.
40. Hofmokl. Wien. med. Presse, 1886, xxviii. 1161, 1196, and 1228.
41. Holmes, B. *Vide* Herrick, N. Y. Med. News, 1893, i. 197, Case 2.
42. Holmes, T. Lancet, 1887, ii. 153.
43. Hulke. Lancet, 1892, ii. 197.
44. Hunnard. Brit. Med. Journ., 1901, i. 514.
45. Jones, D. F. Annals of Surgery, 1903, i. 215, Case 1.
46. Jones, D. F. Ibid., loc. cit., Case 2.
47. Kerr. Annals of Surgery, 1893, ii. 647.
48. Keyes. N. Y. Med. Record, 1887, ii. 781.

49. Knight. New Zealand Med. Jour., Dunedin, 1889-90, iii. 158; quoted by Kerr, Annals of Surgery, 1893, ii. 651.

50. Knoll. *Vide* Herrick, N. Y. Med. News, 1893, i. 197, Case 5.

51. Krabell. Wien. klin. Rundschau, 1901, xv. 213.

52. Lafourcade. *Vide* Bazy, Bull. et Mém. de la Soc. de Chir., Paris, 1903, xxix. 903; also Semaine Méd., 1903, xxiii. 337.

53. Lane, W. Arbuthnot. Lancet, 1892, i. 867.

54. Ledderhose. Verhandl. d. Deutsch. Gesellsch. f. Chir., XXXI. Congr., 1902, ii. 254; also Seldowitsch, Arch. f. klin. Chir., 1904, lxxii. 890.

55. Legueu. *Vide* Dambrin et Papin, Arch. des Mal. des Org. Gén.-Urin., 1904, xxii. 732.

56. Littlewood. Lancet, 1898, ii. 868.

57. Lucas-Championnière. Rev. Gén. de Clin. et de Thérap. (Jour. des Praticiens), Paris 1905, xix. 118.

58. Lyot. *Vide* Dambrin et Papin, Arch. des Mal. des Org. Gén.-Urin., 1904, xxii. 732.

59. MacCormac. Brit. Med. Journ., 1887, i. 1036, Case 1.

60. MacCormac. Ibid., loc. cit., Case 2.

61. McGill. Lancet, 1886, ii. 972.

62. McKeown. Dominion Med. Monthly, Toronto, 1903, xx. 207.

63. McLaren. Scottish Med. and Surg. Jour., 1902, xi. 97, Case 1.

64. McLaren. Ibid., loc. cit., Case 2.

65. Madelung. *Vide* Hellendahl. Inaug. Dissert., Strasburg 1896.

66. Maeder. Deutsch. Zeit. f. Chir., 1905, lxxix. 317.

67. Markoe. *Vide* Connell. Annals of Surgery, 1903, i. 886.

68. Marsh. Lancet, 1893, i. 413.

69. Mayer. Vierteljahrschr. f. gerichtl. Medizin u. offentl. Sanitätswesen, 3 F., Bd. xxviii. Heft I; quoted in Zentralbl. f. Chir., 1904, xxxi. 542.

70. Mikulicz. *Vide* Rose, Deutsch. Zeit. f. Chir., 1890-91, xxxi. 366.

71. Murphy, James. Brit. Med. Jour., 1894, ii. 978.

72. Neilson. Records of Episcopal Hospital, Philadelphia, 1900, No. 913.

73. Ombredonne. *Vide* Dambrin et Papin. Arch. des Mal. des Org. Gén-Urin., 1904, xxii, 732.

74. Page. *Vide* Lloyd, Lancet, 1892, i. 306, Case 2.

75. Pasteau. Bull. et Mém. de la Soc. Anatom. de Paris, 1902, iv. 113.

76. Pedersen. N. Y. Med. Record, 1902, i. 475.

77. Percival. Brit. Med. Journ., 1897, i. 1282.

78. Peters. Amer. Med., 1903, v. 837; also personal communication.

79. Pilcher, L. S. *Vide* Kerr, Annals of Surgery, 1893, ii. 653.

80. Potosky. *Vide* Seldowitsch, Arch. f. klin. Chir., 1904, lxxii. 880.

81. Reclus et Nogues. Revue de Chir., 1890, x. 136.

82. Robinson. Lancet, 1904, i. 219.

83. Roll. Norsk. Magazin for Laegevidenskaben, 1901, No. 5, p. 592; quoted in Deutsch. med. Woch., 1901, xxvii. L-B. 130; also in Zentralbl. f. Chir., 1903, xxx. 646.

84. Rose. Deutsch. Zeit. f. Chir., 1890-91, xxxi. 358.

85. Ryan. Australasian Med. Gaz., 1896, xv. 462.

86. Schlange. Berl. klin. Woch., 1891, xxviii. 688.

87. Schramm. Wien. med. Woch., 1890, xl. 1413.

88. Sonnenburg. Zentralbl. f. Chir., 1885, xii. 838; Berl. klin. Woch., 1885, xxii. 141.

89. Staunton. Indian Med. Gaz., 1889, xxiv. 25.

90. Stukke. *Vide* Seldowitsch, Arch. f. klin. Chir., 1904, lxxii. 865.

91. Symonds. Lancet, 1888, i. 977.

92. Teale. Lancet, 1887, i. 1133.

93. Thorndike. Journ. Cutan. and Gen.-Urin. Dis., 1899, xvii. 212, Case 4.

94. Trojanoff. *Vide* Seldowitsch, Archiv. f. Chir., 1904, lxxii. 882.

95. Trojanoff. Ibid., loc. cit., S. 883.

96. Walsham. Lancet, 1888, i. 173; Brit. Med. Jour., 1888, i. 191.

97. Walsham. Med.-Chir. Trans., 1895, lxxviii. 275.

98. Walter. Phila. Med. and Surg. Reporter, 1861-62, vii. 153.

99. Walter or Valter. *Vide* Seldowitsch, Arch. f. klin. Chir., 1904, lxxii. 882.

100. Walter or Valter. Ibid., loc. cit., S. 882. Mentions six patients, all drunk, all died after operation.

101. Walter or Valter. Ibid., loc. cit.

102. Walter or Valter. Ibid., loc. cit.

103. Walter or Valter. Ibid., loc. cit.

104. Walter or Valter. Ibid., loc. cit.
105. Walter or Valter. Ibid., loc. cit.
106. Weiss. *Vide* Vichard, Thèse de Nancy, 1899; quoted by Dambrin et Papin, Arch. des Mal. des Org. Gén.-Urin., 1904, xxii. 810.
107. Whiteford. Brit. Med. Journ., 1894, ii. 868.
108. Willett. St. Bartholomew's Hospital Rept., 1876, xii. 209.
109. Zeidler. *Vide* Seldowitsch, Arch. f. klin. Chir., 1904, lxxii. 874.
110. Zeldowitsch or Seldowitsch. Archiv. f. klin. Chir., 1904, lxxii. 732.

N. B.—Since going to press Marnoch (Annals of Surgery, 1906, i. 241) has recorded a successful laparotomy for intraperitoneal rupture of the bladder.

EXPERIMENTS ON THE GREAT OMENTUM.

By Leonard S. Dudgeon, M.R.C.P. (Lond.),
BACTERIOLOGIST TO ST. THOMAS' HOSPITAL AND JOINT LECTURER ON GENERAL PATHOLOGY IN THE MEDICAL SCHOOL; DIRECTOR OF THE CLINICAL AND PATHOLOGICAL LABORATORY,

AND

Athole Ross, M.B. (Cantab.),
LATE HOUSE PHYSICIAN TO ST. THOMAS' HOSPITAL, LONDON.

(From the Pathological Department of St. Thomas' Hospital, London.)

The Great Omentum. It is an undoubted fact that the great omentum plays a very important part in the bacteriology of peritonitis, but of still more importance is its relation to cellular pathology.

To Herbert Durham[1] is due the credit of first drawing attention to these facts. It is surprising, therefore, that so little notice should have been paid to the functions of this portion of the peritoneum when we consider the importance of Dr. Durham's valuable paper.

Bacteriology of the Great Omentum. The important part which the omentum plays in peritonitis, if we can judge from surgical text-books, has almost escaped notice.

Klein has remarked that the omentum is intensely injected in guinea-pigs dead from peritonitis, and may sometimes show petechial hemorrhages. This condition, as Durham has already noticed, is a constant feature of peritonitis in both man and animals. In guinea-pigs dead from peritonitis we always find the omentum rolled up toward the diaphragm; this feature of the great omentum may often be observed a few hours after an intraperitoneal injection of a pathogenic organism. The cause of this rolling up is due, as Durham has stated, to the peristaltic movements of the intestines.

The term "chemical peritonitis" introduced by Tavel and Lanz, has now been shown to be incorrect, owing to the researches recently made by Dudgeon and Sargent[2] on the bacteriology of peritonitis.

---

[1] The Mechanism of Reaction to Peritoneal Infection, Journ. Path. and Bact., 1896 and 1897, vol. iv.

[2] The Bacteriology of Peritonitis. Constable, London, 1905.